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(54) Title: GAS MIXTURE, IN PARTICULAR FOR INFLATING THE TYRES OF VEHICLES

(57) Abstract: A gaseous composition particular suitable for inflating the tyres of vehicles presents a high heat transfer capacity. This composition is advantageously based on hydrofluorocarbons, able to effectively conduct the heat generated during the rotation of the tyre to the wheel rim and at a more or less constant pressure. The wheel rim acts as a radiator, exchanging the heat with the outside air, maintaining the tyre temperature low and preventing it from overheating. Tyres inflated with this mixture have a longer life and give better performance.

"GAS MIXTURE, IN PARTICULAR FOR INFLATING THE TYRES OF VEHICLES"

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TECHNICAL FIELD

This invention concerns a gaseous composition particularly suited for use in inflating the tyres of vehicles.

More in particular, this invention refers to a gaseous composition which is designed to be used to inflate the tyres of vehicles to achieve improvements from the point of view of performance and the overall life of the tyre.

This invention can be applied in the industrial sector for the production of non-combustible gases, and in particular in the production of gas mixtures for the inflation of tyres.

BACKGROUND ART

It is known that the tyres of vehicles are inflated with compressed air which is injected into the inner chamber of the tyre through the valve, until the correct working pressure is reached.

It is also known that in the event of long road journeys especially in the summer or in the case of extreme conditions, such as during competitions with sports vehicles, the tyres tend to overheat and the pressure to increase. The hot air in the tyres tends to damage the structure of the tyre due to oxidation and ozonolysis phenomena.

These phenomena produce dangerous and uncontrollable effects on the tyres, which after travelling a certain

distance on the road or track undergo a sudden drop in performance, with a considerable limitation in the life of the tyres as a result of mechanical and thermo-oxidative stress.

In particular, according to the results of standard length track tests, it was found that vehicle tyres normally inflated with compressed air traditionally undergo a sudden drop in performance after the sixth or seventh lap, continuing to decrease and making frequent gear changes necessary.

To overcome this limitation in the performance of air-inflated tyres, the use of gas mixtures was tested and a series of gases were selected on the basis of various properties.

The use of these gases or mixtures did not, however, lead to appreciable results, and it was found that tyres traditionally inflated with these nitrogen, helium or argon-based gaseous mixtures, and the tyres of track sports vehicles, also undergo a sudden drop in performance after a certain number of laps, making it necessary to replace them after a short time.

In fact the critical temperature for some racing tyres is 130°C, over which the tyre "shatters", in other words the part which would normally be worn out on the asphalt surface becomes detached from the pressurised chamber.

The construction of tyres with this known technology is carried out in two stages: the first being the pressure chamber, the second the rubber mix, which is worn out on the asphalt.

When the two parts are superimposed and vulcanised, small air bubbles could remain trapped between the two parts, and an increase in temperature over 130°C would cause them to increase in volume finally forming blisters

that would inevitably explode.

DESCRIPTION OF THE INVENTION

This invention proposes to provide a gaseous mixture or composition that can be used to inflate the tyres of vehicles, thus obtaining improvements from the point of view of performance and of the overall life of the tyre, by controlling the temperature, thus eliminating or at least reducing the disadvantages described above.

The invention also proposes to provide a gaseous composition that be easily produced, thus making it economically advantageous.

This is achieved by means of a gaseous composition for the inflation of vehicle tyres and having the features described in the main claim.

The dependent claims describe advantageous embodiments of the invention.

The gaseous composition according to the invention presents a first fundamental feature, a high capacity of heat transfer. This is therefore a gas mixture that is able to effectively conduct the heat from the rubber tyre during rotation to the wheel rim. The latter, particularly when made from aluminium or magnesium, acts as a radiator, exchanging the heat with the outside air, preventing the tyre from becoming overheated .

Thanks to the high capacity of heat transfer, tyres inflated with this gaseous composition achieve excellent results from the point of view of their life, since the temperature of the tyre is kept low and the pressure is constant. This minimises damage due to oxidation and ozonolysis, thus extending the life of the tyres subjected to mechanical and thermo-oxidative stress.

These gases and mixtures according to the invention are based on gaseous components whose use makes it

possible to achieve the result whereby the more the speed increases the more effective the heat exchange is.

The mixture according to the invention comprises various percentages of a series of hydrofluorocarbons.

According to an advantageous embodiment, these hydrofluorocarbons consist of pentafluoroethane, trifluoroethane and tetrafluoroethane.

According to a particularly advantageous embodiment of the invention, the basic mixture comprises:

Pentafluoroethane HFC 125	44%
Trifluoroethane HFC 143 A	52%
Tetrafluoroethane HFC 134 A	4%

The mixture of these components makes it possible to obtain a base element called HFC R404 A.

According to another advantageous embodiment of the invention, this gaseous mixture can be combined with a certain percentage of carbon dioxide.

In this case, numerous gaseous combinations are possible; however, experiments have demonstrated a particular efficacy of the mixture obtained according to the following composition:

CO_2	50%
HFC 125	22%
HFC 143 A	26%
HFC 134 A	2%

Numerous advantages can be obtained with the use of the mixture according to the invention.

First of all, tyres inflated with this mixture have a constant performance, and the sudden drop in performance does not occur (graph 1). A certain drop in performance was, however detected, but is more gradual and above all occurs after around 11 or 12 laps.

The use of the mixture according to the invention in tyres fitted on motorcycles keeps the pressure more or

less constant, reducing the vibration phenomena which are felt above all on the front tyre (chattering effect).

The rotating mass below the shock absorbers normally has a disturbance frequency of 15 -18Hz, while the more constant pressure achieved with this mixture makes it possible to damp this effect, reducing it to 7 - 9Hz, (data taken from superimposed telemetric systems).

The working temperature also remains below the critical threshold. When the mixture according to this invention is used, the temperature of the tyre never increases beyond 120°C. This is a very important fact considering that the critical temperature for some racing tyres is 130°C, over which the tyre "shatters", i.e. the part that is normally worn out on the asphalt becomes detached from the pressurised chamber.

The new mixture according to the invention absorbs the temperature and transmits it to the wheel rim which acts as a radiator, keeping the temperature of the tyre "low" by exploiting the high heat transmission coefficient of the gas combination which transmits and dissipates the temperature by conduction.

With the new mixture according to the invention, the tyre is subject to less wear, the shavings are four times smaller compared to those with an air-inflated tyre and after a race a mixture-inflated tyre loses half the weight compared to an air-inflated tyre.

Thanks to the use of the mixture according to the invention, it will also be possible to manufacture softer tyres, improving the "grip" and the consequent lap time for competition vehicles, guaranteeing the team a better performance with respect to other tyre manufacturers.

DESCRIPTION OF THE DRAWINGS

Other features and advantages of the invention will

become evident on reading the following description of one embodiment of the invention, given as a non-binding example, with the help of the enclosed drawing, in which figure 1 is a graph representing the performance of tyres in relation to the laps covered on a standard length track in the two conditions of inflation with air and with the gas mixture.

DESCRIPTION OF ONE EMBODIMENT OF THE INVENTION

The gaseous composition according to the invention suitable to be used to inflate vehicle tyres consists of a mixture of hydrofluorocarbons.

In particular, according to a particularly advantageous embodiment, this composition comprises a basic component named HFC R404A consisting of:

- Pentafluoroethane HFC 125 44%
- Trifluoroethane HFC 143 A 52%
- Tetrafluoroethane HFC 134 A 4%

Advantageously, the use of this gaseous mixture can be combined with a certain percentage of carbon dioxide, according to the following preferred composition:

CO_2	50%
HFC 125	22%
HFC 143 A	26%
HFC 134 A	2%

Basically, the gaseous mixtures obtained consist of hydrofluorocarbons and more in general of gases characterised by their high capacity of storing cold heat as well as having a high heat transfer coefficient.

The achieved effects of the mixtures refer mainly to a more constant temperature of the inflated tyres, a more constant pressure and the possibility of using softer mixes, and consequently providing better track performance.

First of all, tyres inflated with this mixture have a constant performance, with no sudden drop, as can be seen in the diagram in figure 1.

As this diagram shows, a certain drop in performance was noted, but this is more gradual and above all it occurs after around 11 or 12 laps.

The table below indicates the data relative to the behaviour of tyres inflated with various gas mixtures and subjected in an artificial environment to temperature and pressure tests on the basis of the test time measured in minutes.

The tests were carried out only on rear tyres since they are more subject to temperature problems.

During the tests the tyres were rotated for a period of time at a certain speed; the speed was then increased until the tyres burst.

The tests were accordingly carried out by rotating the tyres on a surface with a load of 162 kg at an ambient temperature of 25°C and at increasing speeds: for the first 20 minutes at 115 kmph and for subsequent intervals of 10 minutes at increasing speeds from 230 to over 300 kmph.

The first column in the table indicates the various mixtures used in the two rear tyres.

The second column indicates the temperatures of the tyres after 60 minutes of testing and the third column the tyre pressure after 60 minutes.

The fourth column indicates the temperature values when the tyre busts and the fifth the time in minutes after which the tyre burst, while the sixth and last column shows the pressure in bars at the time of bursting.

As can be seen, the mixture giving the best performance is the one indicated in the seventh and the eleventh line, consisting of 50% of 404 and 50% of CO_2.

The results measured with the use of this high-performance mixture indicated the longest times at tyre bursting, i.e. 103 and 117 minutes, which are higher than all the other values.

At the end of the test period, the high-performance mixture made it possible to increase performance by 22.1%, and the tyres burst at a much higher speed, this result being achieved by a lowering of the temperature according to the essential features of the new mixture, and by maintaining the pressure at the inflation values.

Gas Type	Tyre Temp- after 60 min (°C)	Tyre Pressure after 60 min (bar)	Tyre Bursting Temp. (°C)	Tyre Life before Bursting (min)	Tyre Bursting pressure (bar)
Nitrogen Tyre 1			91	33	3.25
Nitrogen Tyre 2	101	3.27	128	84	3.30
Helium Tyre 1			125	55	3.25
Helium Tyre 2	103	3.15	108	85	3.16
CO_2 Tyre 1	94	3.09	136	76	3.11
CO_2 Tyre 2	111	3.10	135	71	3.15
507 Tyre 1	98	3.20	132	89	3.25
507 Tyre 2	88	3.18		91	3.20
404 Tyre 1	92	3.30	119	78	3.34
404 Tyre 2	81	3.25	124	95	3.35
134 Tyre 1	99	3.16	114	70	3.22
134 Tyre 2	92	3.20	112	70	3.21
404 50% CO_2 50%	85	3.00	119	103	3.05
404 75% CO_2 25%	93	3.15	149	101	3.25
507 50% CO_2 50%	91	3.27	157	98	3.35
507 75% CO_2 25%	95	3.27	120	94'	3.35
404 50% CO_2 50%	91	3.15	148 137	117	3.29
404 25% CO_2 75%	93	3.10	137	102	3.18

Once the most suitable mixture had been found, the tyres were analysed to check whether the mixture could

have damaged the elastomer or its components in any way.

The perfect integrity of the elastomer and its main components was confirmed and, thanks to solid state high resolution NMR spectroscopy, the various samples inflated with the various gases and mixtures were compared. These tests confirmed that the sample inflated with the high-performance mixture gave the best results, minimising the damage due to oxidation and ozonolysis, extending the life of the tyres subjected to mechanical and thermo-oxidative stress.

The gas mixture according to the invention can be used in the tyres of airplanes, trucks, articulated trucks, buses, cars or other vehicles, with greater performance in terms of life, rotating silence and lower fuel consumption due to the more stable conditions inside the chamber, all in total safety since the mixture is completely inert. Especially for heavy vehicles, this means that in the event of a tyre catching fire, as a result of its bursting and of the high temperature, the gas would extinguish the fire.

As can be seen, this gas mixture makes it possible to achieve all the results described above, including above all those relative to the fact that the tyres inflated with this mixture give a constant performance and the traditional sudden drop in performance does not occur.

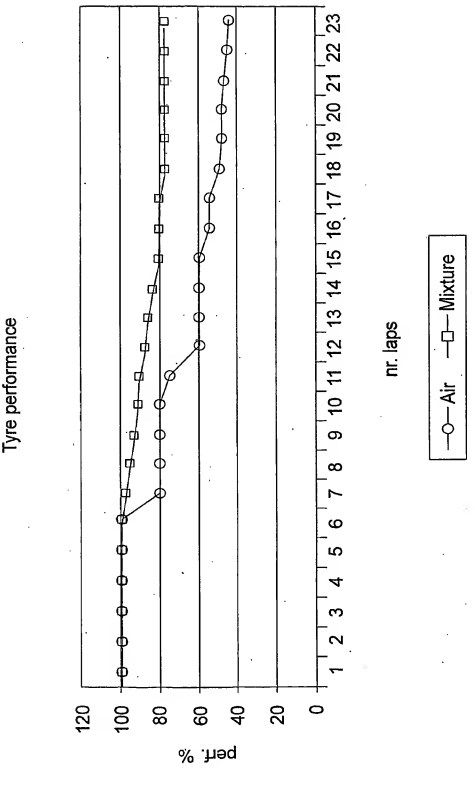
The invention is described above with reference to a preferred embodiment.

It is nevertheless clear that the invention is susceptible to numerous variations, within the framework of technical equivalents.

CLAIMS

1. A gas mixture, in particular for inflating the tyres of vehicles, characterised in that it consists of a mixture with a high heat transfer capacity.
2. A gas mixture suitable for injection to inflate the tyres of vehicles according to claim 1, characterised in that this mixture with a heat transfer capacity consists of hydrofluorocarbon-based compositions.
3. A gas mixture according to one of the foregoing claims, characterised in that this hydrofluorocarbon-based composition comprises a percentage of pentafluoroethane HFC 125.
4. A gas mixture according to one of the foregoing claims, characterised in that this hydrofluorocarbon-based composition comprises a percentage of trifluoroethane HFC 143A.
5. A gas mixture according to one of the foregoing claims, characterised in that this hydrofluorocarbon-based composition comprises a percentage of tetrafluoroethane HFC 134A.
6. A gas mixture according to one of the foregoing claims, characterised in that this hydrofluorocarbon-based composition comprises 44% of Pentafluoroethane HFC 125, 52% of Trifluoroethane HFC 143A and 4% of Tetrafluoroethane HFC 134A, to obtain a basic mixture called HFC 404A.
7. A gas mixture according to one of the foregoing claims, characterised in that it also comprises a percentage of carbon dioxide.
8. A gas mixture according to claim 7, characterised in that the percentage of carbon dioxide is around 50%.
9. A gas mixture according to claim 8, characterised in that it consists of ~~50% of~~ CO_2, 22% of HFC 125 Pentafluoroethane, 26% of HFC 143A Trifluoroethane,

and 2% of HFC 134A Tetrafluoroethane.


Tyre performance
perf. %
120
100
80
60
40
20
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
nr. laps
Air
Mixture

INTERNATIONAL SEARCH REPORT

International Application No
/IT2004/000021

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B60C5/00 C09K5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B60C C09K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002/123436 A1 (WATANABE YASUYUKI ET AL) 5 September 2002 (2002-09-05). column 6, paragraph 80	1-7
X	US 3 877 496 A (SPERBERG LAWRENCE R) 15 April 1975 (1975-04-15) column 1, line 34 - column 2, line 8; claim 1	1,7
A	GB 817 943 A (THOMAS ALFRED OTTO GROSS) 6 August 1959 (1959-08-06)	

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
I/IT2004/000021

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
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GB 817943	A	06-08-1959	US	3047285 A	31-07-1962